3. Excess Fines Design

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3.1. Introduction

This chapter provides a complete discussion of the excess fines design method. The AKFPD excess fines method is approved only for the design of some new, highway pavements. Chapter 2 provides detailed information concerning appropriate applications for this design method.

3.2. Summary of Excess Fines Design

Research leading to development of the excess fines method started in 1976 with the study of 120 asphalt concrete paved road sections throughout Alaska. Results of this research effort are described in reports published between 1980 and 1983.[2–5] An empirically derived design method was generated from this research and officially adopted for use by the Alaska Department of Transportation and Public Facilities (DOT&PF) in 1982.[6] At first, pavement design work was done by hand calculation. By about 1984, the DOT&PF engineering community was gradually introducing a number of different computer programs to handle the computations. Research focused eventually on development of a single, standardized computer program for doing excess fines design. This development process produced the presently used Microsoft Windows-based computer program known as “AKPAVE98.” With slight modification, AKPAVE98 has been incorporated into the AKFPD computer program and will be used to perform an excess fines design.

3.3. Principal Concepts

Alaska’s excess fines design method relies on the following two empirically derived concepts:

1. An empirically definable relationship exists between pavement surface deflection at the center of a standard wheel load and the service life of the pavement in terms of passes of that wheel load. In the case of highway pavement design, the design load has long been standardized in the form of the 18,000 dual-wheeled axle (tire pressure originally defined for the standard load was 80 psi—now 90 psi). This standard axle load is also known as the Equivalent Single Axle Load (ESAL).

   Service Life = f (deflection)

2. An empirically definable relationship exists between pavement surface deflection at the center of a standard wheel load and the amount of P_{200} material contained within individual layers of the pavement structure.

   Deflection = f (amount of P_{200} in aggregate layers)

Simple calculations predict deflection at the surface of the pavement structure based on the amount of P_{200} in each granular layer of the structure. Another calculation determines the thickness of asphalt concrete pavement needed to reduce the predicted deflection level to accommodate a given number of ESALs without pavement failure.

3.3.1 Relationship Between P_{200} Content and Pavement Surface Deflection (A Measure of Pavement Structural Strength)

Based on Alaska DOT&PF research cited previously[2–5] the relationship between P_{200} content and deflection is accounted for by the springtime process of thaw weakening. As wintertime cooling continues, a freezing interface or “freezing front” moves downward through the granular layers of the pavement structure. As the freezing front advances downward, soil moisture continually migrates upward toward the interface between frozen and unfrozen material. The upward transport of moisture during soil freezing satisfies energy balance requirements within the soil mass. After soil moisture reaches the freezing front, it freezes and becomes incorporated as part of the newly frozen soil mass. The process of freezing front progression, upward moisture migration, and freezing continues throughout the winter as long as appropriate temperature gradients exist in the soil. DOT&PF research correlated the amount of frozen moisture accumulating within a particular granular layer to the amount of P_{200} contained in that layer, establishing a relationship between P_{200} and frozen moisture content. Figure 3-1 illustrates the condition of the pavement structure during the freezing process.

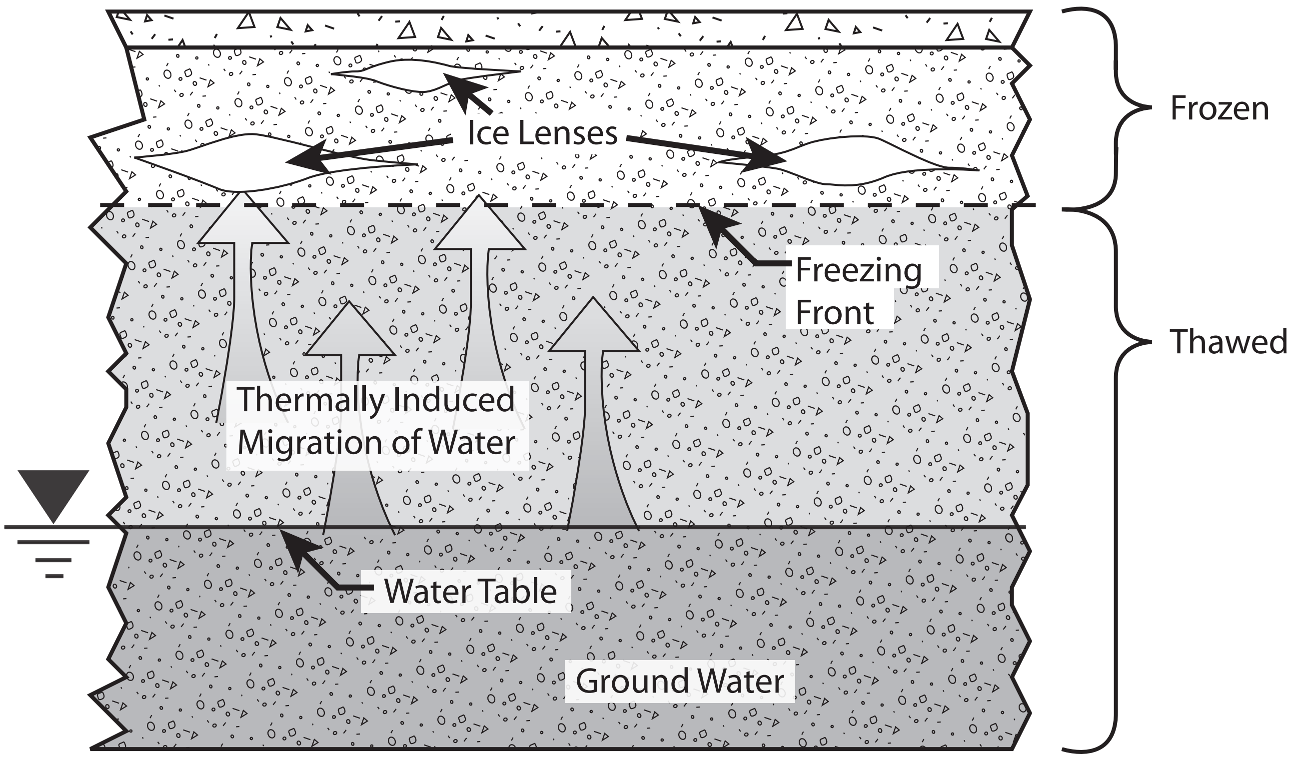


Figure 3-1. Progression of Freezing Front and Ice Formation

As common sense suggests, frozen moisture is of little concern. On the other hand, the combination of springtime thawing and high moisture content in pavement structural layers is very much a problem. DOT&PF research derived a useful functional relationship between thaw weakening of the pavement structure and the amount of P_{200} contained in various layers of the pavement structure. The indicator of thaw weakening employed during the research project was measurement of pavement surface deflection in response to a standard test load, thus establishing a relationship between P_{200} and deflection. The standard test load used during research was the one side of a standard ESAL. The dual wheel set weighed 9,000 pounds total with tire pressures set at 80 psi. Figure 3-2 shows the pavement structure weakened by thaw.

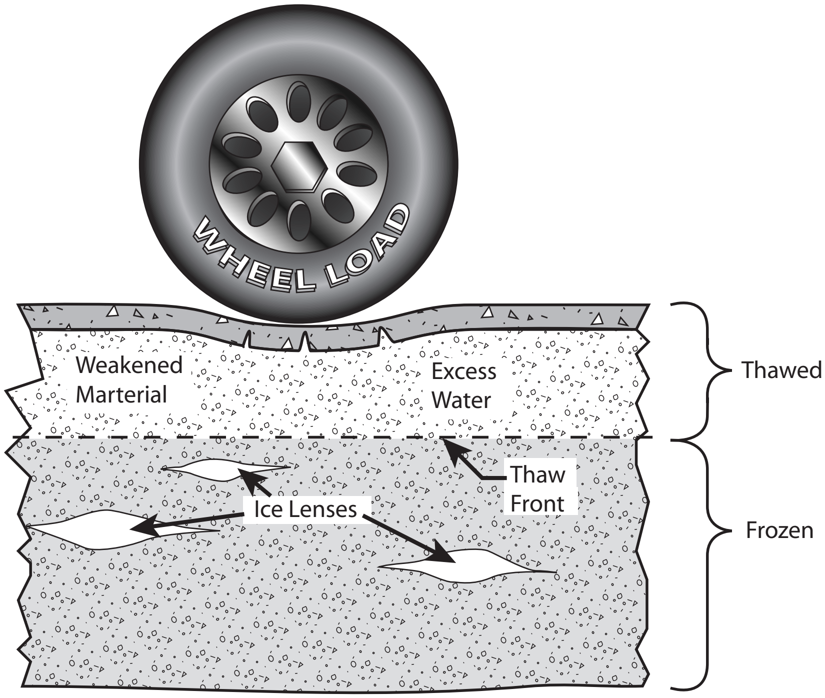


Figure 3-2. Soft Pavement Structure During Thawing

DOT&PF research refined the relationship between P_{200} and deflection by creating a function that attaches increasing importance to high P_{200} contents in upper layers of the pavement structure, which relates to the attenuating distribution of live-load stress with depth. Common sense and research provides the same conclusion: materials deep in the pavement structure "feel" almost none of the vehicle load and are therefore of less concern. Figure 3-3 illustrates the attenuation of strains (also stresses) with depth in the pavement structure.

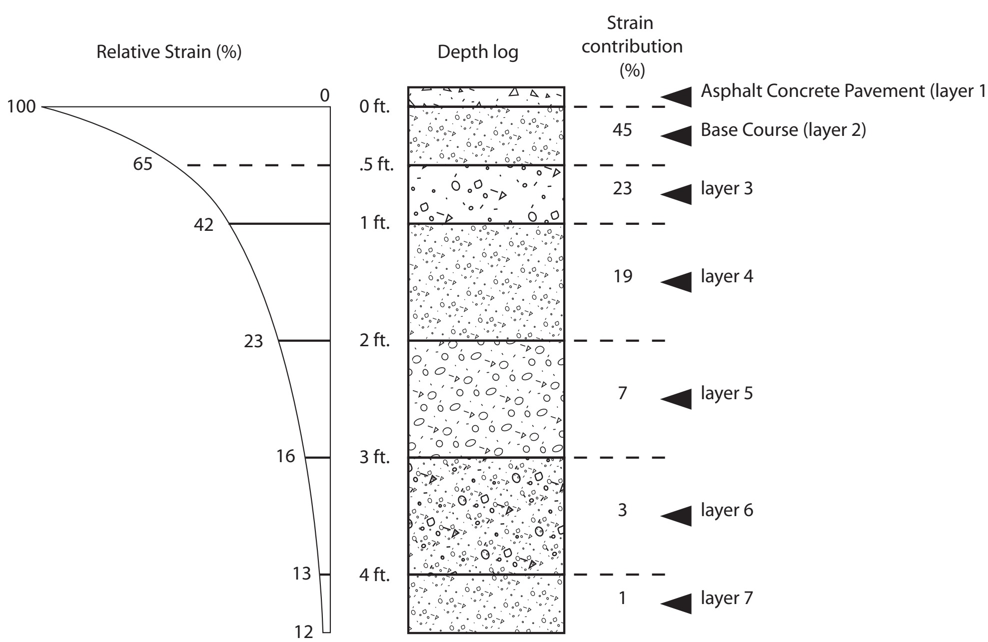


Figure 3-3. Attenuation of Vehicle Load Effect With Depth

3.3.2. Relationship Between Pavement Surface Deflection and Pavement Service Life

As explained above, DOT&PF research derived a functional relationship between aggregate layer P_{200} contents and deflection. However, an additional design step is necessary. The design process requires a relationship between calculated deflection, design ESALs, and required asphalt concrete pavement thickness. For this, DOT&PF modified and adopted The Asphalt Institute's TAI procedure from their 1977 MS-17 publication.[7]

3.3.3. Calculations Used in the Excess Fines Method

Separate each material layer into analysis layers based on the P_{200} content, with a maximum of 1-inch layer thickness. Analyze the pavement structure to a depth of 42 inches below the bottom of the asphalt concrete layer. This can include in-place material in the foundation.

Determine the critical fines content (P_{cr}) for each layer, using Figure 3-4. Enter the vertical axis with the depth from the bottom of the asphalt concrete layer to the top of each aggregate layer and move horizontally to intersect the P_{cr} line. Read the value of P_{cr} for that layer on the horizontal axis.

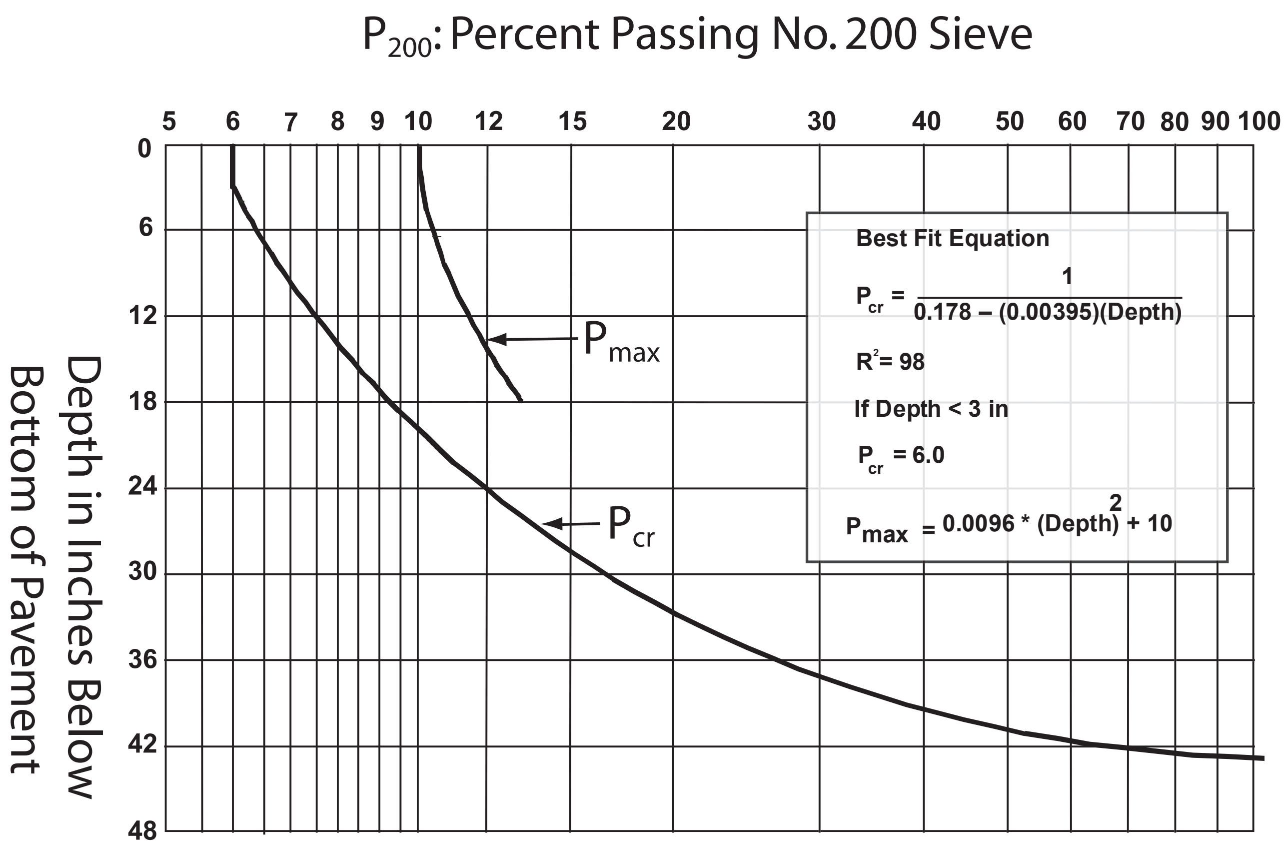


Figure 3-4. Critical and Maximum Fines Versus Depth

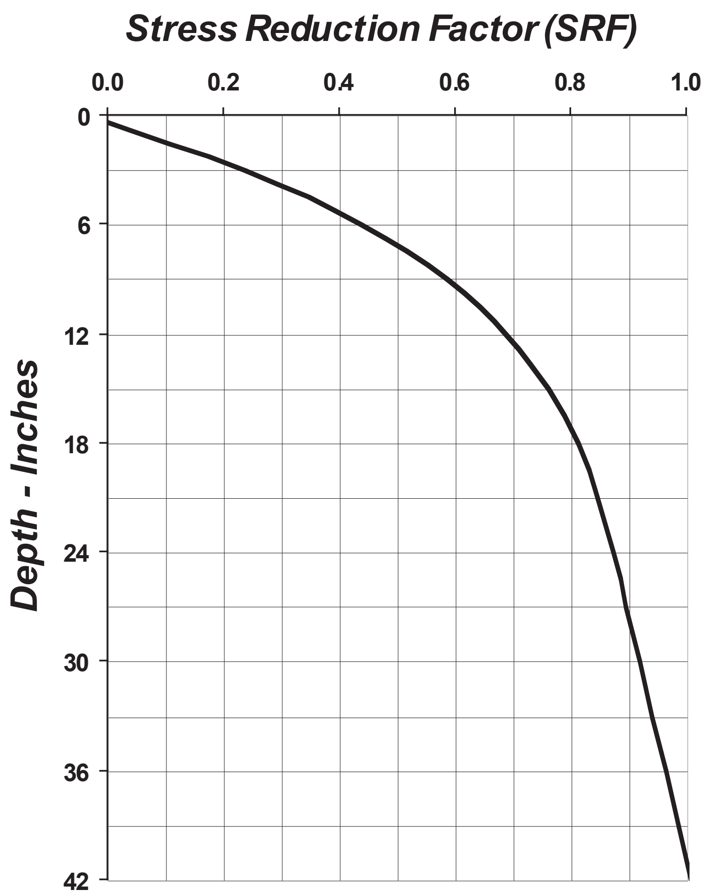
In no case shall the P_{200} exceed P_{max} for an analysis layer (i) with its top between 0 inches and 18 inches beneath the HMA (See P_{max} line on Figure 3-4).

Some materials degrade when crushed and handled. It is important that the P_{200} estimated for the base layer is the anticipated P_{200} of the crushed material after it has been placed and compacted. If the degradation value (Alaska Test Method, ATM T-13) of the material is less than 45, check with the regional materials engineer for guidance.

Calculate the excess fines for each layer (i) to the nearest tenth of a percent. If the calculated excess fines are less than or equal to zero, consider them equal to zero.

$$\text{Excess Fines (i)} = (P_{200} - P_{cr})_i$$

For each such layer (i) find the change in stress reduction factor (ΔSFR). The ΔSRF is equal to the stress reduction factor (SRF) at the bottom of layer (i) minus the SRF at the top of layer (i). SRF is presented in graphical form in Figure 3-5.



$SRF = -7.6477232 \times 10^{-7} y^4 + 9.7898212 \times 10^{-5} y^3 - 0.0046242158 y^2 + 0.10298199 y - 0.034613$

where: y = depth

(If SRF is negative, set SRF to zero)

Stress reduction vs. depth beneath a thin asphalt concrete pavement (assumes homogeneous elastic properties of materials and a standard ESAL loading).

Figure 3-5. Stress Reduction Factor

Calculate the excess fines factor (EFF_i) for each layer, i.

$$EFF_i = (\Delta\ SRF_i)\ [(P_{200} - P_{cr})_i^{\ 0.8}]$$

Add all of the EFF_i values to get EFF_t, i.e., total EFF

$$EFF_t = \sum EFF_i$$

Calculate the predicted maximum deflection, Dp, according to the statistical relationship:

If $EFF_t = 0$, then $Dp = 0.034$

If $EFF_t > 0$, then $Dp = 0.056 + 0.0035(EFF_t)$

Determine the required pavement thickness. Enter Figure 3-6, with the predicted maximum deflection, Dp, on the horizontal axis, move vertically to intersect the appropriate equivalent axle loading (ESAL) curve, and read the required asphalt concrete pavement thickness from the vertical axis. The minimum pavement thickness is 2 inches. The thickness should be rounded up to the nearest .5 inch.

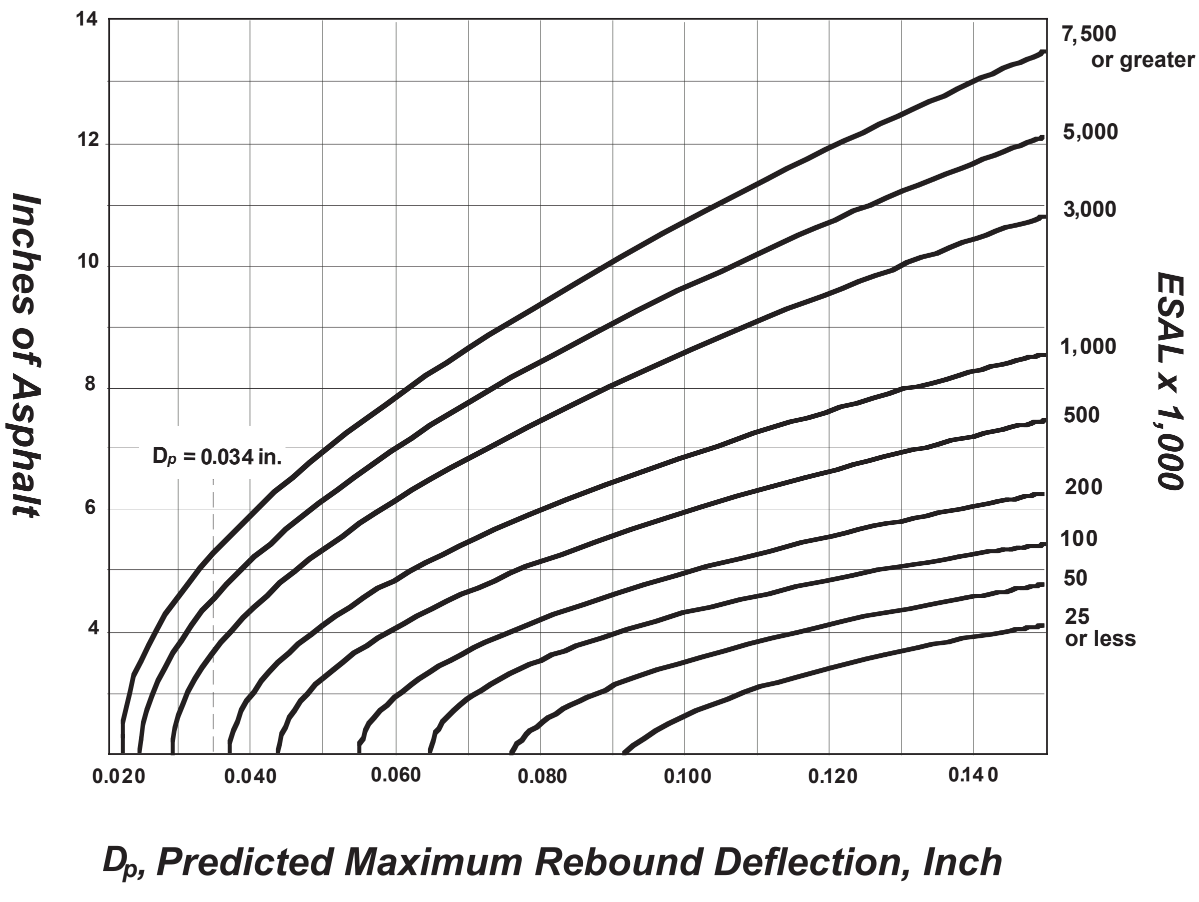


Figure 3-6. Pavement Design Chart

3.4. Stepping Through the Design Process: An Example

This example explains the excess fines design method as a series of simple computational steps. Each computational step in the example is aided by the tabular formatting shown in Table 3-1.

Step 1. Define design ESALs and a system of aggregate layers with P_{200} contents as shown below:

Layer Depth	P_{200} Content (%)
0 inch to 6 inch	8
6 inch to 18 inch	10
18 inch to 42 inch	20

Design ESALs = 1,430,000

Step 2. Subdivide actual layering into layering shown in column 1 of Table 3-1.

Step 3. Enter applicable fines content (P_{200}) in column 2 of Table 3-1.

Step 4. Determine critical fines content (P_{cr}) for each layer from Figure 3-4. Place in column 3 of Table 3-1.

Ensure that P_{200} in the upper 18 inches does not exceed P_{max} in Figure 3-4.

Step 5. Determine excess fines for each layer to the nearest tenth of a percent. Place in column 4 of Table 3-1.

Excess Fines = $P_{200} – P_{cr}$

If $P_{200} – P_{cr} < 0$, then excess fines = 0. Do not use negative values. (See layer 34 in Table 3-1.)

Step 6. Determine the change in stress reduction factor (Δ SRF) for each layer from Figure 3-5. To do this, first locate the SRF at the top of the layer and the SRF at the bottom of the layer. Place these numbers in columns 5 and 6, respectively, of Table 3-1. Then subtract the smaller number (SRF at the top of the layer) from the larger number (SRF at the bottom of the layer). This is best done by calculating the SRFs from the equation shown in Figure 3-5. Place the result for each layer in column 7 of Table 3-1.

Step 7. Determine the excess fines factor (EFF) for each layer, and place in column 8 of Table 3-1.

$$EFF = (\Delta SRF)(P_{200} – P_{cr})^{0.8}$$

Step 8. Sum the EFFs for all layers at the bottom of column 8 of Table 3-1.

Step 9. Determine the predicted maximum deflection (D_p)

EFF > 0, i.e., EFF = 2.1

Therefore: $D_p = 0.056 + 0.0035(EFF_t)$

$D_p = 0.056 + 0.0035\ (2.1)$

$D_p = 0.063$ inch (bottom of Table 3.1)

Step 10. Determine the required asphalt concrete pavement thickness from Figure 3-6.

Entering Figure 3-6 with $D_p = 0.063$ and ESALs = 1,430,000

Figure 3-6 requires pavement thickness = 5.5 inches (rounded up to nearest 0.5 inch)

Table 3-1. Excess Fines Pavement Design Example

Column	1	2	3	4	5	6	7	8
Obtained From:	Trial Dimensions	Specifications or Field Data	Figure 3.4	Column 2 minus Column 3	Figure 3.5	Figure 3.5	Column 6 minus Column 5	Column (7) * $(4)^{0.8}$
Layer Number	Depth Interval (inches)	Fines Content (P_{200})	Critical Fines (P_{cr})	Excess Fines	SRF at Top of Layer	SRF at Bottom of Layer	(ΔSRF)	(EFF)
1	0 to 1	8	6.0	2.0	0.0	0.064	0.064	0.11
2	1 to 2	8	6.0	2.0	0.064	0.154	0.090	0.16
3	2 to 3	8	6.0	2.0	0.154	0.235	0.081	0.14
4	3 to 4	8	6.0	2.0	0.235	0.309	0.074	0.13
5	4 to 5	8	6.2	1.8	0.309	0.376	0.067	0.11
6	5 to 6	8	6.3	1.7	0.376	0.437	0.061	0.09
7	6 to 7	10	6.5	3.5	0.437	0.491	0.054	0.15
8	7 to 8	10	6.7	3.3	0.491	0.540	0.049	0.13
9	8 to 9	10	6.8	3.2	0.540	0.584	0.044	0.11
10	9 to 10	10	7.0	3.0	0.584	0.623	0.039	0.09
11	10 to 11	10	7.2	2.8	0.623	0.658	0.035	0.08
12	11 to 12	10	7.4	2.6	0.658	0.689	0.031	0.07
13	12 to 13	10	7.7	2.3	0.689	0.716	0.027	0.05
14	13 to 14	10	7.9	2.1	0.716	0.740	0.024	0.04
15	14 to 15	10	8.1	1.9	0.740	0.761	0.021	0.04
16	15 to 16	10	8.4	1.6	0.761	0.780	0.019	0.03
17	16 to 17	10	8.7	1.3	0.780	0.797	0.017	0.02
18	17 to 18	10	9.0	1.0	0.797	0.811	0.014	0.01
19	18 to 19	20	9.4	10.6	0.811	0.825	0.014	0.09
20	19 to 20	20	9.7	10.3	0.825	0.836	0.011	0.07
21	20 to 21	20	10.1	9.9	0.836	0.847	0.011	0.07
22	21 to 22	20	10.5	9.5	0.847	0.856	0.009	0.05
23	22 to 23	20	11.0	9.0	0.856	0.865	0.009	0.05
24	23 to 24	20	11.5	8.5	0.865	0.873	0.008	0.04
25	24 to 25	20	12.0	8.0	0.873	0.881	0.008	0.04
26	25 to 26	20	12.6	7.4	0.881	0.888	0.007	0.03
27	26 to 27	20	13.3	6.7	0.888	0.895	0.007	0.03
28	27 to 28	20	14.0	6.0	0.895	0.902	0.007	0.03
29	28 to 29	20	14.8	5.2	0.902	0.910	0.008	0.03
30	29 to 30	20	15.8	4.2	0.910	0.917	0.007	0.02
31	30 to 31	20	16.8	3.2	0.917	0.924	0.007	0.02
32	31 to 32	20	18.0	2.0	0.924	0.932	0.008	0.01
33	32 to 33	20	19.4	0.6	0.932	0.939	0.007	0.00
34	33 to 34	20	21.0	0.0	0.939	0.947	0.008	0.00
35	34 to 35	20	22.9	0.0	0.947	0.955	0.008	0.00
36	35 to 36	20	25.2	0.0	0.955	0.963	0.008	0.00
37	36 to 37	20	27.9	0.0	0.963	0.971	0.008	0.00
38	37 to 38	20	31.4	0.0	0.971	0.979	0.008	0.00
39	38 to 39	20	35.8	0.0	0.979	0.986	0.007	0.00
40	39 to 40	20	41.8	0.0	0.986	≈ 1.0	0.014	0.00

Calculations: Predicted Deflection: D_p = 0.063 $EFF_t = \Sigma EFF$ =

If $EFF_t = 0$ then $D_p = 0.034$ Total of Column 8 = 2.1

If $EFF_t > 0$ then $D_p = 0.056 + 0.0035\,(EFF_t)$

Pavement thickness from Figure 3-6 (Enter with D_p on the horizontal axis, rise vertically to curve for design ESALs, then horizontally to read pavement thickness on vertical axis) = 5.5 inch for 1,430,000 ESALs

3.5. Excess Fines Design Using the AKFPD Computer Program

Perform excess fines designs for projects using the AKFPD program. The previous example "by hand" was meant to acquaint you with the computations used by AKFPD.

3.5.1. Generalized Steps Through the Program

1. The designer assembles design input data:
   - Design ESAL data supplied by Regional Planning Section (see chapter 6)
   - P_{200} content of each layer of material that will be used to a depth of 42 inches below the asphalt concrete pavement layer
   - Proposed thickness of each layer
2. The designer loads data to AKFPD input screen and runs program.
3. AKFPD subdivides each aggregate layer into 1-inch-thick sublayers.
4. AKFPD assigns each sublayer the appropriate P_{200} content at that depth (using the P_{200} contents entered as design input data).
5. AKFPD calculates the amount of pavement deflection that would occur if the pavement structure were to be subjected to the dual tire loading from one side of a standard ESAL axle.* Pavement deflection is a function dependent on (1) the percent P_{200} at each sublayer depth and (2) the amount of load support contributed by each sublayer (derived from Boussinesq stress distribution theory).

   * The standard ESAL wheel load is now defined as two tires, each inflated to 90 psi, each loaded to 4,500 lbs, with a centerline-to-centerline separation of 13.5 inches.
6. AKFPD then calculates the required asphalt concrete pavement thickness. Pavement thickness is a function dependent on (1) pavement deflection and (2) the total number of design ESALs.
7. If the calculated asphalt concrete thickness is not acceptable, the designer adjusts the input data and reruns AKFPD.

3.5.2. Example 1—Getting Started and Performing a Simple Design

The following steps lead you through a simple example of AKFPD excess fines pavement design analysis and interpretation of the results.

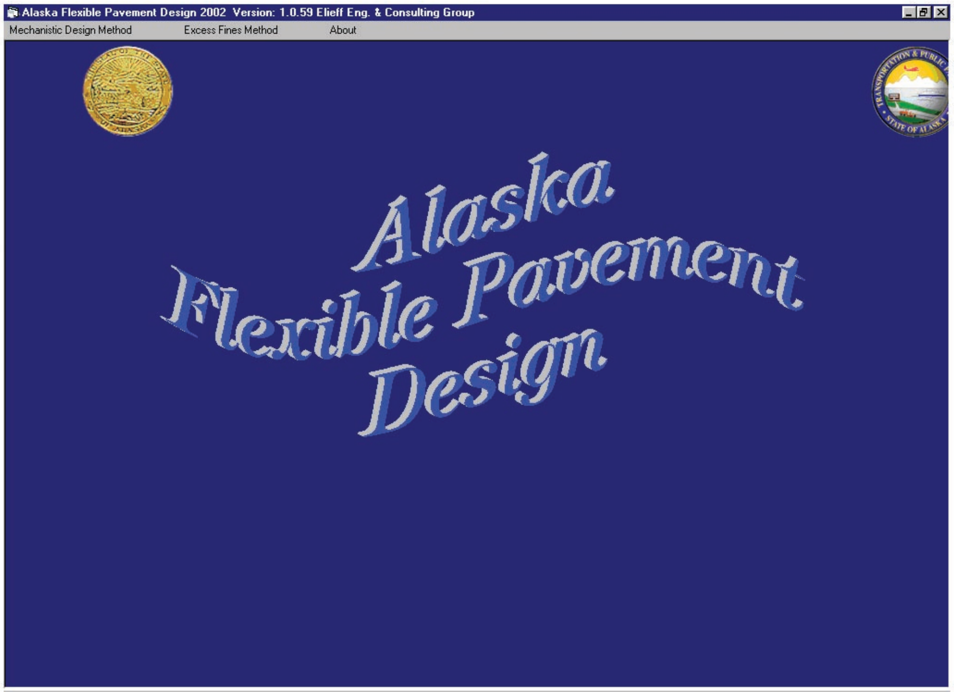
The first design example, which is explained in detail, does not use a previously saved input data file. You will use a previously saved input data file in the next example.

Mouse clicks are single clicks of the left button of computer mouse configured in the standard operating mode.

Step 1. Insert the AKFPD program CD disk into your computer's CD drive.

Step 2. Install AKFPD on your computer. If the software does not autoload, locate a listing of the CD's contents using the MS Windows ***My Computer Explore*** feature and run the "setup.exe" file. Alternatively, use the MS Windows ***Start Run*** feature by typing in the appropriate CD disk drive and the filename "setup.exe." The program can be removed by accessing the ***Start Control Panel*** feature of your computer, then selecting ***Add/Remove Programs***. From the list of installed programs select "Alaska Flexible Pavement Design 2003" and proceed with the uninstall process.

Step 3. Run AKFPD. Initiate the ***Start Programs*** feature of Windows, and from the listing of programs, run "Alaska Flexible Pavement Design 2003." The AKFPD title screen will appear (see Screen Clip 3-1):



Screen Clip 3-1

Step 4. Near the top left corner of the introductory screen, two program design method options are offered. One of the options is labeled ***Excess Fines Method***. Using your mouse, click on that option. A pull-down menu will appear (see Screen Clip 3-2).

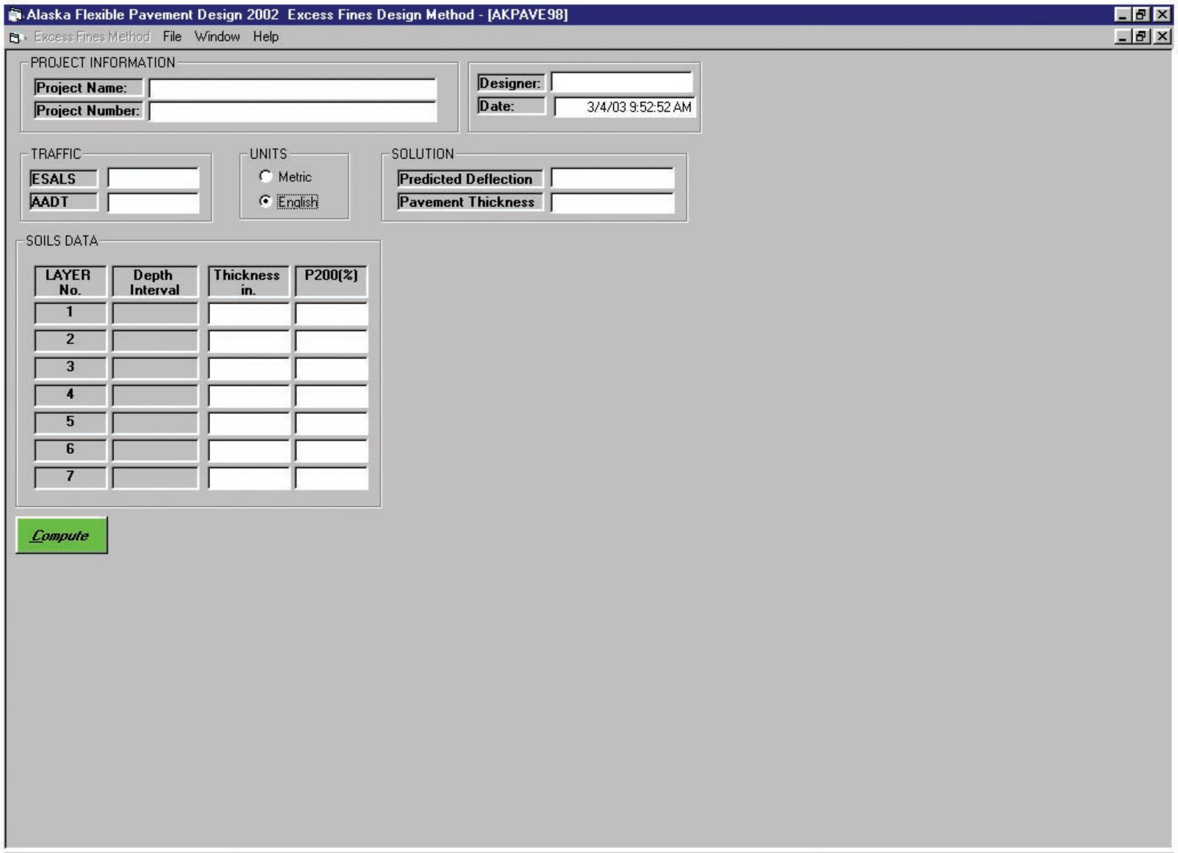
Screen Clip 3-2

Step 5. You now have two new options:

a. Click on ***New Analysis*** to begin a completely new excess fines pavement design. A blank design input data screen will appear that you must fill in before performing the analysis.

b. Click on ***Open Existing*** to begin an analysis using a previously saved input data file. The previously saved file can be analyzed without modification, or the file can be opened and modified before analysis.

Step 6. This example uses the ***New Analysis*** option. Clicking on that one brings up the input screen (see Screen Clip 3-3). This screen will contain all input and output data for the analysis.



Screen Clip 3-3

All data items required for doing the complete excess fines analysis are typed as input onto the input screen or selected/deselected on the screen by mouse click. The following steps explain input values necessary to fill various areas of the screen.

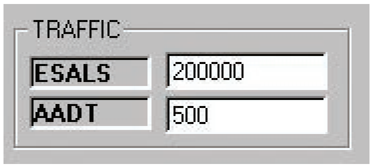
Step 7. Use the ***Project Information*** section of the input screen (see Screen Clip 3-4) for entering project identification information.

Fill the ***Project Name, Project Number,*** and ***Designer*** designator boxes with appropriate alphanumeric characters as in the Screen Clip 3-4. Select each box in turn with the mouse, and then initiate the prompt with a single mouse click. AKFPD automatically updates the ***Date*** box.

Screen Clip 3-4

To continue with the example, use your mouse to select applicable fields on your AKFPD input screen and type in the data indicated in Screen Clip 3-4.

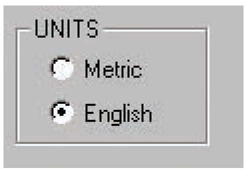
Step 8. Use the screen's ***Traffic*** section (see Screen Clip 3-5) for entering design traffic information. Select the box to the right of ***ESALS*** and type in the project's design ESALs. Then select the box to the right of ***AADT*** and type in the project's average annual daily traffic.



Screen Clip 3-5

To continue with the example, use your mouse to designate applicable fields on your AKFPD input screen and type in the data indicated in Screen Clip 3-5.

Step 9. The units section of the input screen contains toggles for selecting the system of numerical units to be used in the analysis (see Screen Clip 3-6). To operate the toggles, point your mouse button at the circle to the left of ***Metric*** or ***English*** and click the mouse's left button.

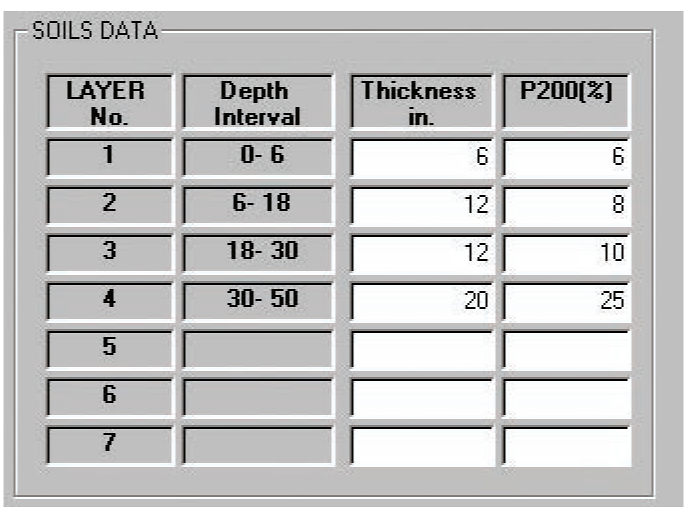


Screen Clip 3-6

To continue with the example, use your mouse to designate the ***English*** field.

Step 10. Use the ***Soils Data*** area of the screen to enter the thickness of each layer and each layer's P_{200} content (see Screen Clip 3-7). P_{200} is defined as the weight percent passing the #200 sieve. Enter layer thickness in inches in the column labeled ***Thickness.*** Enter the P_{200} content of each layer in the column labeled ***P200(%).***

Type in thickness and P_{200} data starting with layer 1, then proceed downward, in order, through layers 2, 3, 4, etc. Notice that as layer thickness is entered for succeeding layers, the program keeps track of the depth intervals occupied by each layer. The sum of the layer thicknesses entered must be ≥ 42 inches (or ≥ 1,067 mm if metric units are used).

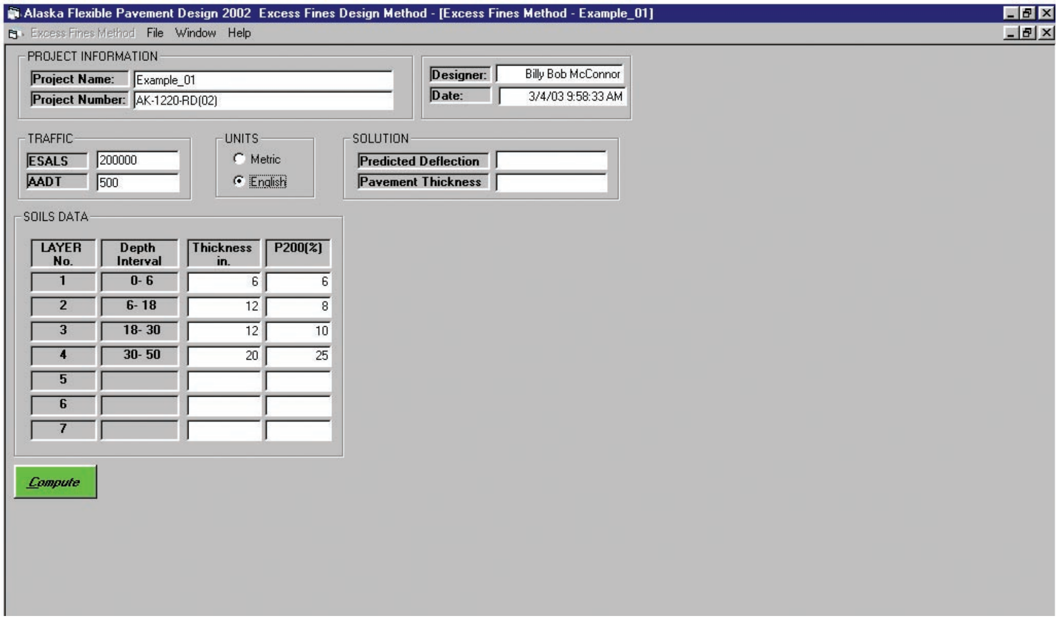

SOILS DATA

LAYER No.	Depth Interval	Thickness in.	P200(%)
1	0- 6	6	6
2	6- 18	12	8
3	18- 30	12	10
4	30- 50	20	25
5			
6			
7			

Screen Clip 3-7

To continue with the example, use your mouse to select applicable fields and type in the data indicated in Screen Clip 3-7.

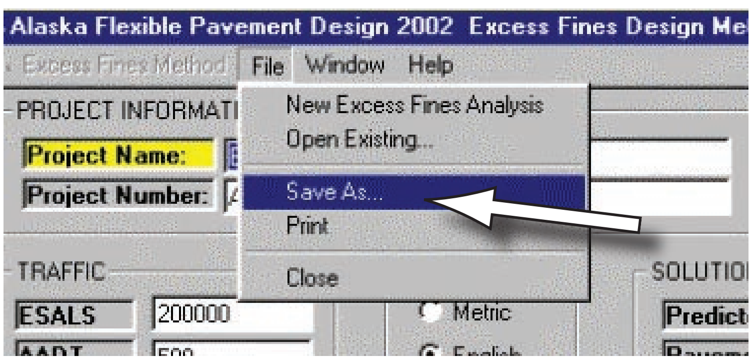
Step 11. Your completed input screen should look like the one shown in Screen Clip 3-8. If it does not, use your mouse to select fields where data will need to be changed. Enter corrections as required until your input screen appears as shown.



Screen Clip 3-8

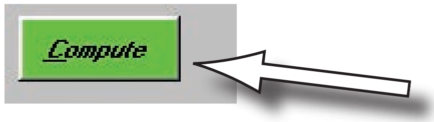
When you complete the input screen as indicated, you are ready to analyze the input data.

Step 12. You may now save your input data screen by assessing the ***File, Save As*** command shown in Screen Clip 3-9. Once saved, the input screen can be opened later using the ***File, Open Existing*** commands and analyzed as explained below. The input screen can also be opened and the data modified before analysis. Section 3.4.3 further explains the process of saving and recalling data.



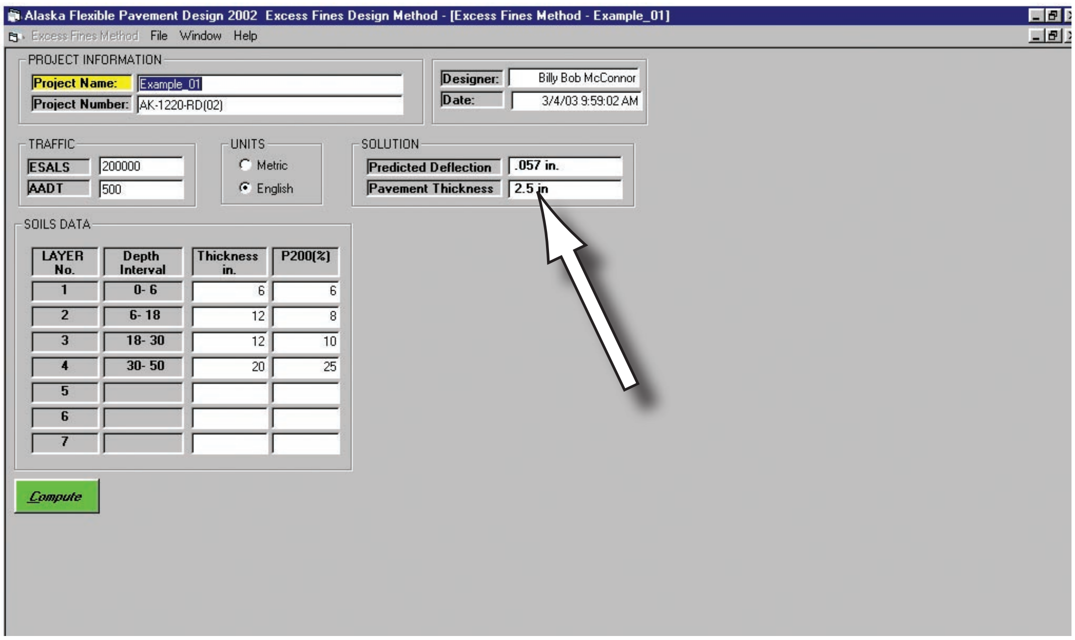
Screen Clip 3-9

Step 13. Perform the analysis and print the results. Initiate the computation by clicking on the ***Compute*** button located on the side of the screen (see Screen Clip 3-10).



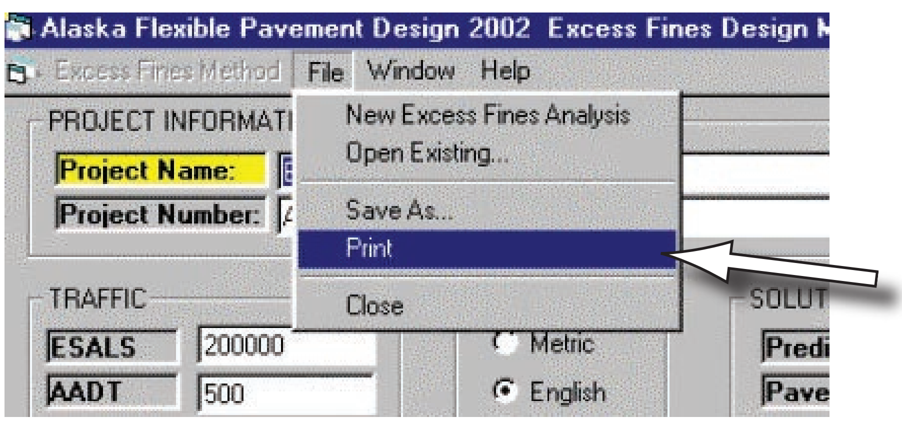
Screen Clip 3-10

After you activate the ***Compute*** button, the ***Solution*** section of the screen will contain the results of the analysis as shown in Screen Clip 3-11.



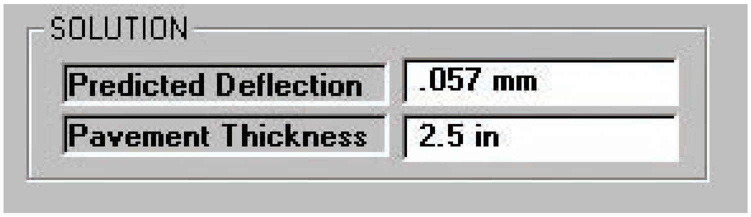
Screen Clip 3-11

Print the screen, containing both input and output data, by clicking the ***File, Print*** command as indicated in Screen Clip 3-12.



Screen Clip 3-12

Step 14. Interpret the results. The results of the example 1 analysis consist of the two values shown Screen Clip 3-13.



Screen Clip 3-13

The AKFPD program uses calculations described in Section 3.2.3 to arrive at the ***Predicted Deflection*** of 0.057 inch shown above. Using the predicted deflection of 0.057 inches and the 200,000 design ESAL, AKFPD applies a numerical version of Figure 3-6 to determine the required asphalt concrete pavement thickness of 2.5 inches. In this case, no further interpretation is necessary—you will specify a minimum asphalt concrete thickness of 2.5 inches.

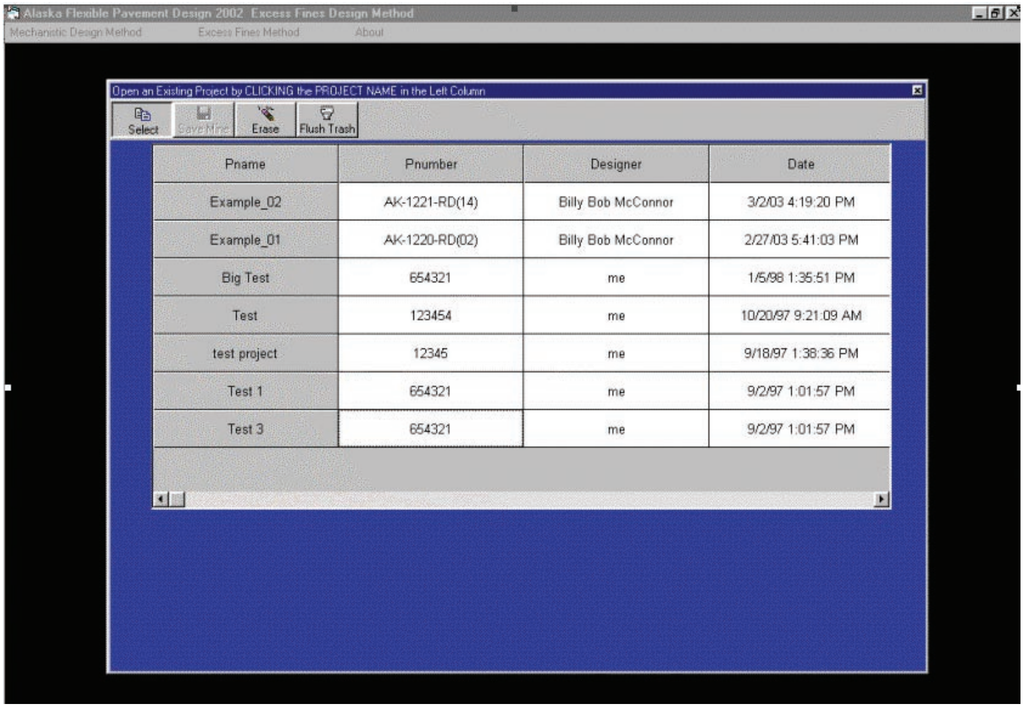
3.5.3. Saving, Recalling, and Modifying Files

Saving and Recalling the Input Screen

When you start the AKFPD program you can recall an existing data file (and modify it as necessary) instead of inputting new analysis data. Recall an existing file by accessing the ***Open Existing*** command on the ***Excess Fines Method*** pull-down menu from AKFPD's opening screen (see Screen Clip 3-14).

Screen Clip 3-14

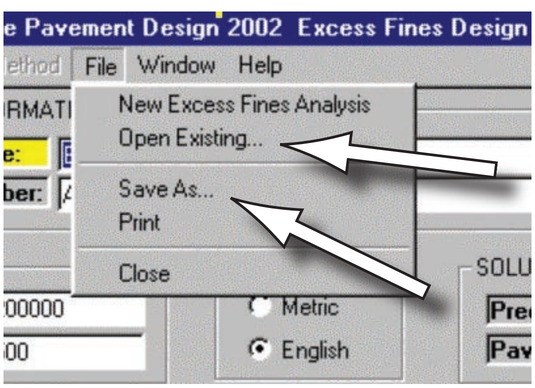
If you select the ***Open Existing*** option, a menu similar to that shown in Screen Clip 3-15 appears. Use your mouse to point and click on one of the data files to open it.



Screen Clip 3-15

Using the menu shown in Screen Clip 3-15, you can remove a data file from the menu by clicking on the menu's ***Erase*** button. Mark one or more of the menu selections for removal, then click on the Flush Trash button.

During the analysis process you can save or open an existing data file. Save input screen data by accessing the ***File, Save As*** command indicated in Screen Clip 3-16. Once saved, the input screen can be opened later using the ***File, Open Existing*** commands and analyzed. Of course, the input screen can also be opened and the data modified before analysis.



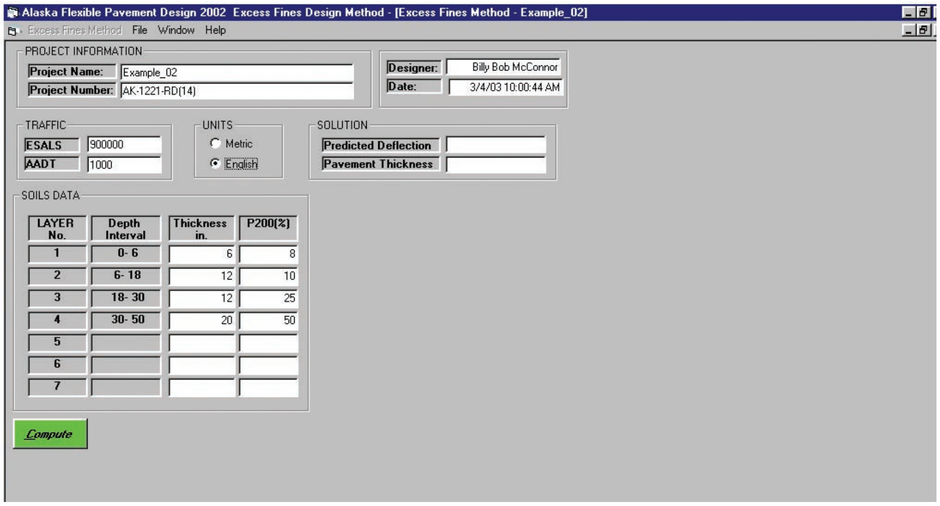
Screen Clip 3-16

3.5.4. Example 2—A Design Requiring Thick Pavement

This example considers a case where the excess fines design method will require a pavement thickness of more than 3 inches. When the design process requires more than 3 inches of pavement, an additional section of information appears on the excess fines input/output screen. The new section provides a table of alternatives where pavement thickness can be "swapped" for some thickness of stabilized base course. The simple methodology for doing this is shown in the following steps.

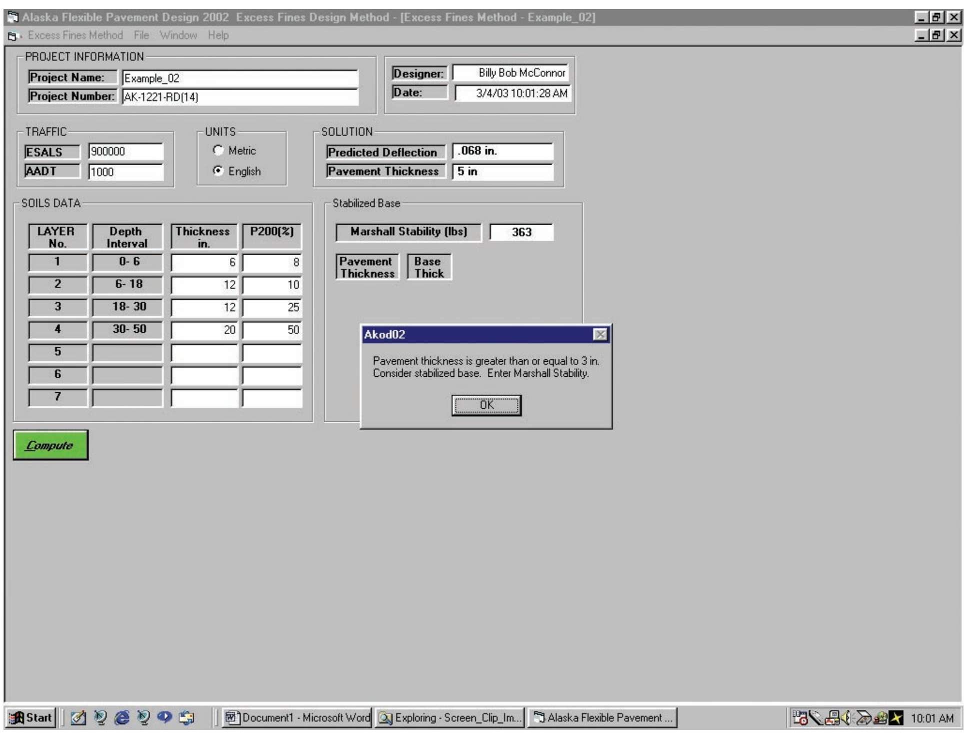
Keep in mind that any combinations of reduced pavement thickness and stabilized base course thickness are in ***addition*** to the thickness of unbound, crushed base course that you specified in the design.

Step 1. Begin this example design by initiating the ***Excess Fines Method, New Analysis*** input screen as described in example 1. When the input screen appears, use mouse and keyboard to fill the data fields as shown in Screen Clip 3-17. Make sure the input screen appears as shown in Screen Clip 3-17 before moving on.



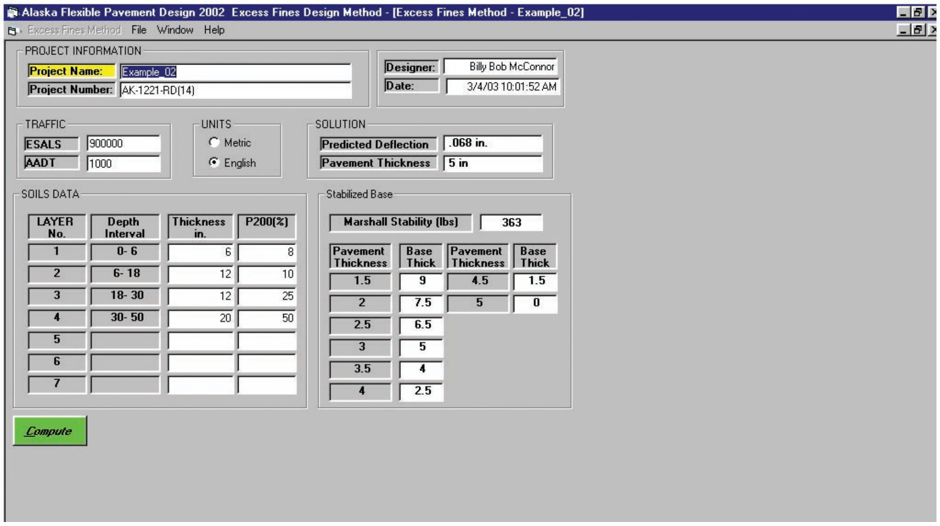
Screen Clip 3-17

Step 2. Do the analysis and print the results. Click on the ***Compute*** button at the lower left of the input/output screen. The screen will then appear as in Screen Clip 3-18.



Screen Clip 3-18

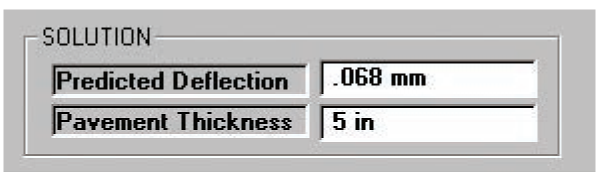
When this screen appears, click the ***OK*** button and the next screen will appear as in Screen Clip 3-19.



Screen Clip 3-19

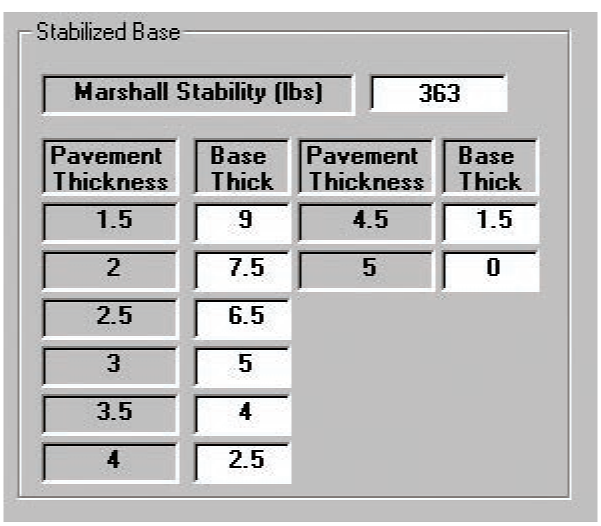
Print the input/output shown in Screen Clip 3-19 by using your mouse to activate the ***File, Print*** commands at the top of the screen.

Step 3. Interpret the results of the analysis. The ***Solution*** section of the screen (see Screen Clip 3-20) indicates that 5 inches of pavement is required.



Screen Clip 3-20

However, the thickness "swap" table, shown in Screen Clip 3-21, contains the information you need to select from a number of different pavement thickness/ stabilized base thickness combinations.

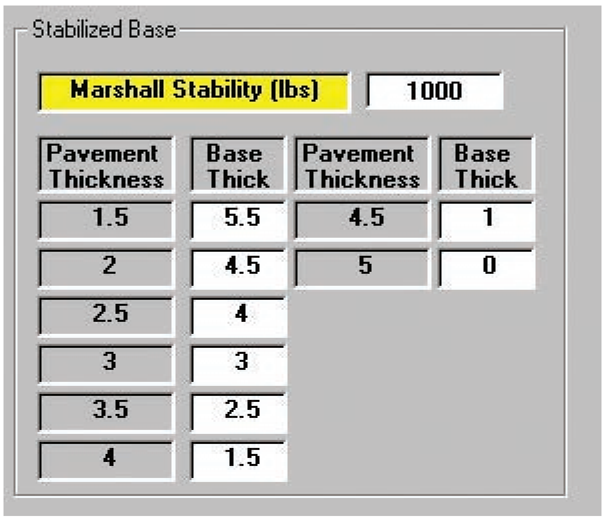


Screen Clip 3-21

Interpretation of this table shown in Screen Clip 3-21 is simple. Starting at the bottom of the table (bottom of right column), you can see that if no stabilized base is used, the full 5 inches of pavement thickness is required. Moving the top of the table (top of left column), a pavement thickness of only 1.5 inches is acceptable if combined with 9 inches of stabilized base. The list also contains a number of other equally valid combinations. Regardless of which combination you select from the table, however, you must ***also*** use all layers of materials you used as input—in this example, that includes the 6 inches of normal base course used as an input material layer.

You can obtain an estimation of the ***Marshall Stability*** (shown in Screen Clip 3-21 as 363 lbs) from your regional or headquarters materials experts. A presumptive value can be used or laboratory testing can be done to obtain actual Marshall stability. If you decide on laboratory testing, make every attempt to test materials obtained from design project sources.

You can change the Marshall stability to any value you choose by typing a new number into the Marshall Stability data field, followed by pushing **Return** on your keyboard. Notice that if you change the Marshall stability value to 1,000 lbs, the table will change as indicated below.



Screen Clip 3-22